# The potential risk of communication media in conveying critical information in the aircraft maintenance organisation: a case study



2016 IOP Conf. Ser.: Mater. Sci. Eng. 152 012044

(http://iopscience.iop.org/1757-899X/152/1/012044)

IOP Conf. Series: Materials Science and Engineering **152** (2016) 012044 doi:10.1088/1757-899X/152/1/012044

# The potential risk of communication media in conveying critical information in the aircraft maintenance organisation: a case study

**S Ahmad Shukri[1*], R M Millar[2], G Gratton[3] and M Garner[4]**
[1]Universiti Kuala Lumpur - Malaysian Institute of Aviation Technology, Malaysia
[2]University of Aberdeen, Scotland
[3]Brunel University, West London
[4]Whitelands College, University of Roehampton, London

*suhailah@unikl.edu.my

**Abstract**. In the world of aircraft maintenance organisation, verbal and written communication plays a pivotal role in transferring critical information in relation to aircraft safety and efficiency. The communication media used to convey the critical information between departments at an aircraft maintenance organisation have potential risk in misunderstanding of the information. In this study, technical and non-technical personnel from five different departments at an aircraft maintenance organisation were interviewed on the communication media they normally utilised to communicate six different work procedures that are closely related to aircraft safety and efficiency. This is to discover which communication media pose higher risk in misunderstanding critical information. The findings reveal that written communication pose higher risk of misinterpretation compared with verbal communication when conveying critical information between departments.

## 1. Introduction

Civil aviation is a highly regulated industry controlled by numerous national regulatory bodies such as the UK Civil Aviation Authority (UKCAA), the US Federal Aviation Administration (FAA) and the Department of Civil Aviation Malaysia (DCAM). In order to ensure the safety of aircraft and the people on board, pilots must be trained and licensed. For the same reason, Aircraft Maintenance Technicians (AMT) and Aircraft Maintenance Engineers (AME) must be trained and certified to maintain and repair the complex system of aircraft so that they are airworthy. Research into human factors has contributed significantly to understanding what contributes to aircraft failures. The International Civil Aviation Organization (ICAO) and National Aviation Authorities (NAA) are very much concerned with the crucial human contribution to aircraft safety, and have undertaken a great deal of research into human factors, particularly the importance of communication in aviation maintenance organizations. As such, many studies are undertaken aiming to understand the causes of communication errors and find solutions to mitigate incidents that might affect safety. By analysing areas of potential inefficiencies in communication in a critical organisational communication system, the study reported here reveal the type of communication media used in the aircraft maintenance organisation and the work procedures that have higher risk in misunderstanding critical information.

### *1.1. Communication theories*

Communication system consists of five parts; a message, a transmitter which operates on the message to produce a signal channel, the receiver and the destination [1]. Ma *et al.* (2008) explained that the

basic communication process consists of speaker (people, documents, machines etc), the message (information, feelings, etc) the medium (telephone, speech, text, etc) barriers (psychological, physical & physiological noise) and feedback [2]. Communication in an organisation involves media choices that can help to convey the message effectively. The media that are used for transferring a message; critical and non-critical information, have evolved tremendously over the years; from letter writing, phone calls, face to face discussion to advanced technology; electronic mail, teleconferencing, video chat and voice calls [3]. One theory that highlights the effectiveness and capability of the media in transferring information is the Media Richness Theory (MRT) [3, 4]. The theory is about the choice of the medium made by managers and subordinates in order to accomplish a task that may carry ambiguous information [5]. Richness of a medium is defined when four features below are fulfilled in getting a message across:

- Immediate feedback of the message
- Use of various cues (body language, voice, pictures, and so forth)
- Use of natural language
- Personal focus on the medium

A message is considered lean when one or more of the features is absent. Failure of communication therefore occurs due to misunderstanding or the message. The view of communication failure taken here is inspired by Cushing's (1994) definitions of communication breakdown between a pilot and a traffic controller [6], with the definition being modified to account for the reasons for communication failures during the performance of maintenance, repair and overhaul on aircraft:

- A message that is unavailable
- A message that is available but incomplete
- A message that is available and complete but incorrect
- A message that is available, complete and correct but not clear
- A message that is available, complete, correct and clear, but not understood
- A message that is available, complete, correct, clear and understood but mistakes still happen due to human factors

The involvement of human factors cannot be denied as the act of reading and interpreting documents comprises of the skills and experience of both the writer and the reader of the documents. Next, the errors that are commonly found in documents that lead to aircraft maintenance errors are highlighted.

### *1.2. Aircraft maintenance errors*

To err is human, to forgive divine. The proverb illustrates that it is human nature to never be free from making mistakes. Knowing the fact that humans are susceptible to errors, it is important to identify the contributing factors of errors and the type of errors that may lead to aircraft incidence and/or accidents, also to understand and relate the causes of good practices that leads to aircraft safety and efficiency. It is stressed that one of the factors of maintenance errors is confusion, misunderstanding or differences of opinion about the procedures [7]. Apart from human and organizational factors, documentation error can also cause technicians to make mistakes as listed below [8]:

- Contributing factors or procedural error that cause technician to err
  - Information not understandable
  - Information incorrect
  - Information not enough
  - Information not used
  - Information unavailable
- Maintenance error type-unexpected discrepancy made by technician
  - Improper documentation
  - Wrong procedure

With regards to procedural compliance, there are several reasons for maintenance personnel to not following the procedures given. Civil Aviation Authority (CAA) highlights them as follow [9]:

- The inaccuracy of the procedures
- The procedures are not practical to perform
- Difficult to find information within the written instructions
- Unclear policy on the usage of the procedures

- Rely on skills and experience when performing task
- Unaware of the existence of procedures for certain task

In relation to effects of errors in the written media, maintenance errors were predominantly due to maintenance personnel forgetting a step (60%) during the maintenance work, followed by incorrect installation with 32% and installing using wrong components with 8% (see Figure 1) [10]. However, according to Chaparro et al (2001), the failure to comply with maintenance documents was the main reason for system malfunction, especially when the content of the documents comprise of unclear, insufficient and false information [11]. Confidential Human Factors Incident Reporting Programme (CHIRP) in 2007 reported that mistakes most repeatedly made are not following procedures and not using information that is readily available and to rectify these problems, the producers of the documents are recommended to make sure that the procedures are user friendly and to have an association of the company task cards with the Aircraft Maintenance Manual [12].

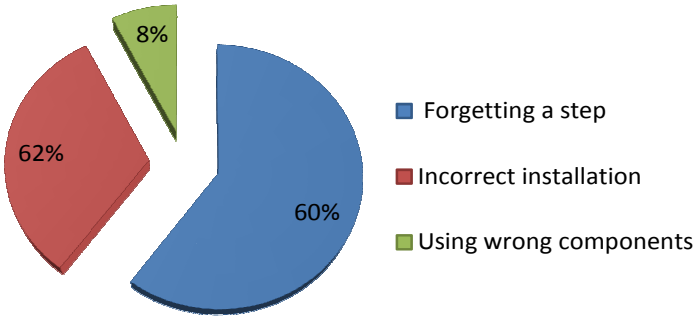


**Figure 1.** Maintenance errors

## 2. Methodology

*2.1. Data gathering*

This case study started with an exploratory research by interviewing technical and non-technical employees from an aviation maintenance organization. The exploratory research is conducted to investigate a new field of which little is known and in this case study, there is no study to the best of the researcher's knowledge that has been carried out in discovering the inter-department and inter-organization communication media in the aircraft maintenance organization and the possible risks the media may carry in conveying the critical information. To explore something new, the researcher employed a semi-structured interview as it is a widely used method for gathering data in social research and can help discover another person's knowledge and experience depending on the breadth and depth of the questions asked. The semi-structured interview was then used to allow participants to provide their own account of daily operations in communicating the critical information between departments. Individual interviews were conducted to let each participant feel comfortable in expressing his/ her thoughts especially when they were talking about the communication issues they had with their colleagues. Interviewing professionals will help to differentiate between process knowledge and context knowledge. Process knowledge is designed to discover a certain type of process, for example, in this case, study, the communication process between departments in GrA, the communication problems they face and the process of addressing those issues. Context knowledge, on the other hand, focuses on the frequency of those communication problems and the role played by individuals or team responsible in helping to solve those issues.

The interview data was gathered at a regional (Malaysian) subsidiary of a major aircraft manufacturer providing sales and maintenance support on behalf of the Original Equipment Manufacturer (OEM). For the purpose of confidentiality as requested by the organisation's top management, the aircraft maintenance organization being studied is fictitiously named as Grand Air (GrA). It consisted of six core departments and one unit; Quality Assurance (QAD), Aircraft Management (AMD), Planning (PD), Supply Chain and Logistics (SCLD), Engineering (ED),Technical Publication Unit (TPU) that is under the Engineering Services (ESD) and Flight Operation (FO). Only thirty three personnel were interested to be interviewed. The interviews were

conducted in the respective departments, only when the employees were available. The data was audio recorded using a digital recorder, with the permission of the informants, and transcribed. Analysis of the data identified themes relevant to the research questions was then paraphrased and summarized for quoting.

*2.2. Departmental procedures*

Once all the interviews were completed, the next step was to list the critical procedures of each department that linked up to the engineering department. This could only be done after the researcher obtained a full view based on how each department communicated between departments and between organisations. It was essential to divide these procedures into two organizational levels: inter-departmental and inter-organizational communication for the purpose of exploring which communication medium, through these procedures, poses a high risk of conveying critical information that may affect aircraft safety and efficiency. Table 1 below is the list of GrA Inter-departmental communication, which consists of seven core procedures. The communication media and their frequency used in each of the inter-departmental procedures will be further discussed below.

**Table 1:** GrA Inter-departmental communication

| Department | Procedures |
|---|---|
| Quality Assurance department communication with all departments | Audit |
| Aircraft management department communication with Planning department | Aircraft Status List & Maintenance Forecast |
| Planning department communication with Aircraft Management department | Return of Completed Work Pack of Scheduled Maintenance |
| Planning department communication with Engineering department | Work Package Delivery |
| Engineering department communication strategies with supply chain/ logistic department | Request for Aircraft Spares |
| Engineering department communication with Flight Operation | Flight Test Procedures |
| Technical Publication Unit communication with core departments | Technical Documentations from Aircraft Manufacturer (Service Bulletin & Alert Bulletin ) and European Aviation Safety Agency (Airworthiness Directives) |

## 3. Data analysis

Data were gathered during the first phase of exploratory research. Selection of data of what was deemed essential in answering the research questions was necessary. Even though employees from eleven departments were interviewed, however, only six departments and one unit, namely the Quality Assurance Department, Aircraft Maintenance Department, Planning Department, Supply Chain and Logistics Department, Engineering Department, Technical Publication Unit and Flight Operation communication strategies were chosen to be analysed. This was because the departments had a closer link to the engineering departments in terms of communicating critical information that had potential effects on aircraft safety and efficiency.

The findings from the interview data relating to each department and communication media was divided into two: verbal and written media. The verbal media consisted of scheduled and unscheduled meetings, telephone calls and face to face communication whereas the written media consists of System Software, Email, documents and fax. The legend (from never (0) to always (4)) helped the researcher to insert the frequency of communication used in the respective departments gathered based on the interview data and on the researcher's interpretation. Once the data were inserted, further analysis of the data was displayed through the risk assessment model. Risk assessment was introduced in this study as an additional analysis to the qualitative data to find out

which communication media presented the highest risk of transferring critical information. Risk assessment is widely used in the engineering field to predict component failures to system failures of in an engineering product, for example in nuclear power, oil and gas, health science, aerospace industries, etc. Table 2 below is the risk assessment matrix developed to indicate GrA communication media used in transferring critical information based on its inter-departmental communication procedures.

**Table 2.** GrA inter-departmental communication risk assessment matrix

| | | | | | |
|---|---|---|---|---|---|
| 1<br>Very High | 5<br>Low | 20<br>Medium | 45<br>High | 80<br>Extreme | 125<br>Extreme |
| 2<br>High | 4<br>Low | 16<br>Low | 36<br>Medium | 64<br>High | 100<br>Extreme |
| 3<br>Medium | 3<br>Low | 12<br>Low | 27<br>Medium | 48<br>High | 75<br>High |
| 4<br>Low | 2<br>Low | 8<br>Low | 18<br>Medium | 32<br>Medium | 50<br>High |
| 5<br>Very Low | 1<br>Low | 4<br>Low | 9<br>Low | 16<br>Low | 25<br>High |
| Scale of Impact | 1<br>Insignificant | 2<br>Minor | 3<br>Moderate | 4<br>Major | 5<br>Catastrophic |

It is important to note that in measuring risk, there are different levels of risk measurement that are motivated by various circumstances. Table 3 indicates the risk rating for the assessment matrix. The reason for the rating is being classified as such indicates the level of risk of both verbal and written media used in communicating critical information based on the critical procedures of each GrA core department with other departments. The low level shows that the critical information being conveyed by the media used present very little indication of miscommunication between departments and organisations and it does not have a serious impact on aircraft safety and efficiency. However, the medium level of risk though does not show an alarming sign of risk but does need attention so that the media used can be improved to prevent further escalation of conveying misunderstood information. The high level of risk rating demonstrates a worrying indication that the media used to communicate critical information can possibly affect aircraft safety and efficiency and needs to be attended to, to eliminate misunderstanding. The final level is the extreme risk rating. When a procedure being conveyed through the media and they are identified as delivering the highest level of misunderstood information, to a point that the outcome is catastrophic to aircraft safety and efficiency, then the media needs to be re-evaluated and enhanced so that unwanted incidents can be avoided.

Table 4 indicates the classifications for the frequency of communication media being used between departments and between organisations in GrA. ‘Never’ represents the verbal and written media are not used at all to convey critical information. ‘Seldom’ demonstrates that the verbal or written media are rarely used to convey the critical message while ‘Sometimes’ indicates that the media are occasionally used to transfer critical information. ‘Often’ informs us that the verbal and written media are used regularly, however ‘Always’ illustrates that the media are used constantly to convey the critical information. Table 5 shows the frequency, probability and consequences classification of GrA communication media

## 4. Results

### *4.1. The participants’ demographic background*

Out of 70 technical and non-technical personnel from the eight departments, only thirty three employees volunteered to participate in the interview. Table 6 below shows the distribution of the interview subjects based on gender, age, nationality and position. There were twenty seven (82%) males and six (18%) females that were interviewed and ten of them (30%) were between thirty six and forty years old, while nine (27%) represented between thirty one and thirty five and another eight

(24%) were between forty and above. However, only six (18%) were between twenty five and thirty years old. Most of the subjects were Malaysians with 32 (97%) while only one French (3%). The subjects interviewed held different positions. Eight (24%) of them were managers from eight departments, five (15%) were assistant managers, three (11%) executives, one senior officer, inspector and a pilot (3%) each, seven senior technician (21%), three (11%) junior technicians, with another two being (6%) officers.

**Table 3.** Risk rating and action based on calculation

| **Risk Calculations** Frequency*Probability*Consequences | **Risk Rating** | **Actions** |
|---|---|---|
| Frequency (3) x Probability (2) x Consequences (2) = 12 | Low 1 - 16 | Even though the risk is low, small errors need correction |
| Frequency (3) x Probability (3) x Consequences (3) = 27 | Medium 17 - 36 | Close monitoring of work process needed |
| Frequency (5) x Probability (3) x Consequences (3) = 45 | High 37 - 79 | Fast action needed to rectify problems |
| Frequency (5) x Probability (5) x Consequences (5) = 125 | Extreme 80 - 125 | Discontinue of work immediately to prevent serious risk of injury |

**Table 4.** Frequency classification of GrA communication media

| | | | | | |
|---|---|---|---|---|---|
| **Frequency** | **Never (1)** Verbal or written media are not used to convey critical information | **Seldom (2)** Verbal or written media are rarely used to convey critical information | **Sometimes (3)** Verbal or written media are occasionally used to convey critical information | **Often (4)** Verbal or written media are regularly used to convey critical information | **Always (5)** Verbal or written media are constantly used to convey critical information |

**Table 5.** Frequency, probability and consequences classification of GrA communication media

| **Consequences** | **Frequency** | **Work Performance** | **Probability** |
|---|---|---|---|
| Insignificant (1) | Never (1) Verbal or written media are not used to convey critical information | Trivial maintenance error done due to outdated reference | Very low (1) May occur only in exceptional circumstances |
| Minor (2) | Seldom (2) Verbal or written media are rarely used to convey critical information | Small maintenance errors due to misunderstanding of instructions | Low (2) Could occur at some time |
| Moderate (3) | Sometimes (3) Verbal or written media are occasionally used to convey critical information | Tolerable delay of maintenance work due to non-conforming aircraft products from manufacturer | Medium (3) Possible to occur at some time |
| Major (4) | Often (4) Verbal or written media are regularly used to convey critical information | Major maintenance errors made due to incorrect or misunderstanding of maintenance manual | High (4) Likely to occur at some time |
| Catastrophic (5) | Always (5) Verbal or written media are constantly used to convey critical information | Severe maintenance errors made due to misunderstanding of instructions and failure to comply with standard operating procedures and regulations | Very High (5) Expected to occur in most circumstances |

**Table 6.** Participants' demographic background based on gender, age, nationality and position (n=33)

| **Characteristics** | | | | |
|---|---|---|---|---|
| Gender: | | | | |
| | Male | 27 (82%) | | |
| | Female | 6 (18%) | | |
| Age: | | | | |
| | 25 – 30 | 6 (18%) | | |
| | 31 – 35 | 9 (27%) | | |
| | 36 – 40 | 10 (30%) | | |
| | 40 and above | 8 (24%) | | |
| Nationality: | Malaysian | 32 (97%) | | |
| | French | 1 (3%) | | |
| Position: | | | | |
| | Manager | 8 (24%) | Senior Technician | 7 (21%) |
| | Assistant Manager | 5 (15%) | Junior Technician | 3 (11%) |
| | Executive | 3 (11%) | Pilot | 1 (3%) |
| | Senior Officer | 1 (3%) | Officer | 2 (6%) |
| | Inspector | 1 (3%) | | |

*4.2. GrA inter-departmental communication*

The results of the analysis were first presented by communication media used within each department. The core departments, namely the Quality Assurance (QAD), Aircraft Management Department (AMD), Planning Department (PD), Supply Chain and Logistics Department (SCLD), Engineering Department (ED) and the Technical Publication Unit (TPU), which is located under the Engineering Services Department (ESD). The communication media used to communicate with each other with regards to daily aircraft maintenance operations were:-

- 'Unscheduled Meeting' (meetings called when necessary to discuss important or urgent matters)
- 'Face to face' (regular social interaction between personnel discussing work)
- 'Documents' (written sources of critical information used to refer to and act upon)
- 'Scheduled meetings' (formal meeting with set dates, agendas and minutes)

From the interview data and observation, it was found that scheduled meetings were very rare at GrA, especially at the executive level: they took place between once a month and once in every three months. At unscheduled meetings, the manager of the department briefed the staff on the critical nature of certain issues. When asked why this approach was used, managers commented that they preferred to deal with daily issues as they arise, talking to their staff face to face about what problems they encountered, discussed and finding solutions. This medium of communication was observed in almost all departments. Most of the staff indicated that they were comfortable with this approach as an efficient way of solving many issues rather than spending a lot of time in meeting rooms. The document was essential when dealing with identification and traceability of critical information. In all departments, these three communication media were supplemented by email as records to keep track of information that was passed on and/ or needed urgent attention.

'System software' was used mainly by Aircraft Maintenance Department, Planning Department, Engineering Department, Supply Chain and Logistics Department. This was used based on the Aircraft Status List & Maintenance Forecast Procedures that required these four departments to communicate with each other using the System software. Phone calls were used much less frequently than face to face communication as the departments were in close proximity. Staff members were frequently observed to walk to the other department and had face to face contact in order to question, reaffirm, show or discuss issues on certain documents that may seem difficult to explain on the phone.

The results of the risk assessment focused on the communication media used in inter-department and inter-organizational at GrA. The data multiplications of risk assessment were designed to identify

those communication media that presented the greatest potential for conveying incorrect information. The findings were categorised into verbal and written media. The former include scheduled and unscheduled meetings, telephone calls and face to face communication; the latter includes software, email, controlled documentation and faxes. The frequency of use of the media was derived from the interview data. Next, we shall look at the level of risk in conveying incorrect information through the analysis of communication medium from various work procedures.

*4.2.1. Quality assurance department communication strategies with all departments on audit procedures.* As shown in Table 7, it was found that the Quality Assurance Department scored 20, low in risk, in conveying incorrect information by using face to face meetings and email to communicate the audit. The incorrect information coming from this department to other departments would create a delay of audit preparation and might affect the audit plan. However, it did not have a direct impact on aircraft safety and efficiency, but would rather slow down audit plan activities.

**Table 7.** Quality assurance department communicating audit procedures

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Document** | **Fax** |
| Frequency | 5 | 5 | 4 | 5 | 1 | 5 | 5 | 1 |
| Probability of miscommunication | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| Consequences of miscommunication | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| Triple multiple | **20** MEDIUM | **20** MEDIUM | **16** LOW | **20** MED | **1** LOW | **20** MED | **20** MED | **1** LOW |

*4.2.2. Aircraft management department communication strategies with planning department on aircraft status list and maintenance forecast procedures.* The outcome scales in Table 8 clearly indicates that the written media (Software and Controlled documentation) used between Aircraft Management Department and Planning Department in relation to the Aircraft Status List and Maintenance Forecast Procedures present the highest score of 45. This provides a serious miscommunication indication that may negatively affect maintenance work in relation to these media. This was due to the wrong information from the documents being keyed into the software system where the aircraft status list and maintenance forecasting information passed the planners. The same information was then transferred to the Engineering department and incorrect maintenance work took place.

**Table 8.** Aircraft management department communicating aircraft status list and maintenance forecasting procedures

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 2 | 2 | 2 | 1 | 5 | 2 | 5 | 1 |
| Probability of miscommunication | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 1 |
| Consequences of miscommunication | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 1 |
| Triple multiple = | **2** LOW | **2** LOW | **8** LOW | **1** LOW | **45** **HIGH** | **8** LOW | **45** **HIGH** | **1** LOW |

*4.2.3. Planning department communication strategies with aircraft management department on return of completed work pack of scheduled maintenance.* The incorrect information conveyed through software and document is rather low here with a score of 16 (Table 9). This was due to the insertion or update of information that was written in the work pack for the Aircraft Maintenance Department personnel to check and verify.

**Table 9.** Planning department communicating the return of completed work pack of scheduled maintenance

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 2 | 2 | 1 | 4 | 4 | 2 | 4 | 1 |
| Probability of miscommunication | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| Consequences of miscommunication | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| Triple multiple = | **2** | **2** | **1** | **4** | **16** | **2** | **16** | **1** |
| | LOW | LOW | LOW | LOW | LOW | LOW | LOW | LOW |

*4.2.4. Planning department communication strategies with engineering department on work package delivery.* Table 10 shows that this procedure scored 20. This indicates a low risk of conveying incorrect information as the information was mainly on incorrect dates, signature, aircraft part numbers or reporting the procedures of the maintenance work being done on the aircraft.

*4.2.5. Engineering department communication strategies with supply chain/logistic department on request for aircraft spares.* Table 11 indicates that in communicating this procedure with the Supply Chain and Logistics Department, the Engineering Department scored 16 in the controlled documentation. This was due to the wrong request of aircraft spares when ground crew referred to incorrect aircraft manuals or illustrated parts catalogue prior to maintenance work on aircraft. When the Aircraft Maintenance Technicians realized they had wrongly requested the parts, requesting a new one might take a longer amount of time if it was not available at the Supply Chain and Logistics Department. The Engineering Department personnel felt that this did not affect aircraft safety and efficiency as it would be detected before commencing the work by double checking the aircraft manual and work packages.

**Table 10.** Planning department communicating work package delivery

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 3 | 4 | 3 | 4 | 2 | 3 | 5 | 1 |
| Probability of miscommunication | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Consequences of miscommunication | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Triple multiple = | **3** | **4** | **3** | **4** | **2** | **3** | **20** | **1** |
| | LOW | LOW | LOW | LOW | LOW | LOW | MEDIUM | LOW |

**Table 11.** Engineering department communicating requisition of aircraft spare

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 2 | 3 | 4 | 4 | 1 | 3 | 4 | 1 |
| Probability of miscommunication | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Consequences of miscommunication | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Triple multiple = | **2** | **3** | **4** | **4** | **1** | **3** | **16** | **1** |
| | LOW | LOW | LOW | LOW | LOW | LOW | LOW | LOW |

*4.2.6. Engineering department communication strategies with flight operation on flight test procedures.* Another indication of the low risk of incorrect information is when the Engineering Department communicated with Flight Operation on flight test planning (Table 12). The wrong information was caused by incorrect information on the dates and time for flight test and which aircraft to flight test on, which did not have any effect on flight safety and efficiency.

*4.2.7. Technical publication unit communication with core departments on technical documentations received from aircraft manufacturer (Service Bulletin & Alert Bulletin) and EASA (Airworthiness Directives).* It was found that the written media (email and controlled documentation) used between the technical publication unit and the other core departments on technical documents scored 45 as shown in Table 13, and thus posed a high risk of miscommunication. This would happen especially if the technical documents were not being updated. The wrong information found in the technical document, if not corrected, could be used as a reference during maintenance work and eventually lead to serious maintenance error done on the aircraft.

## 5. Discussion

The results show that out of seven core inter-departmental procedures, only two procedures indicate a high risk of conveying incorrect information connected to written communication which is considered to be a less rich media as it has the potential to convey an equivocal message. In this case, the lean media could potentially affect aircraft safety and efficiency due to its heavy usage of written media in transferring the critical information.

**Table 12.** Engineering department communicating flight test procedures

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 2 | 3 | 3 | 4 | 1 | 2 | 4 | 1 |
| Probability of miscommunication | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| Consequences of miscommunication | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| Triple multiple = | **2** | **3** | **12** | **16** | **1** | **2** | **16** | **1** |
| | LOW | LOW | LOW | LOW | LOW | LOW | LOW | LOW |

**Table 13.** Technical publication unit communicating technical documents

| | **Verbal block** | | | | **Written block** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Meetings** | | **Phone call** | **F2F** | **Software** | **Email** | **Controlled** | |
| | **Scheduled** | **Unscheduled** | | | | | **Documentation** | **Fax** |
| Frequency | 4 | 3 | 3 | 4 | 1 | 5 | 5 | 3 |
| Probability of miscommunication | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 |
| Consequences of miscommunication | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 |
| Triple multiple = | **4** | **3** | **3** | **4** | **1** | **45** | **45** | **3** |
| | LOW | LOW | LOW | LOW | LOW | **HIGH** | **HIGH** | LOW |

There are two inter-department and three inter-organization communication procedures that are found to pose a high risk in conveying critical information through written media as listed below:

- Aircraft Maintenance Department with Planning Department on Aircraft Status List
- Technical Publication Unit with GrA core departments on technical documents

The case study clearly indicates that using software and Controlled documentation between Aircraft Management and Planning departments to communicate on aircraft status list and maintenance forecasting procedures result in miscommunication that may negatively affect maintenance work. Based on the interviewees' comments, the danger of miscommunication arises from the manual insertion of critical information in relation to the aircraft maintenance forecasting into the software. The information may lead to misinterpretation by the planners which is then transferred into the Work Package (WP). Unless the planners realize the incorrect information and inform the Aircraft Management Department to amend them, incorrect maintenance work ensues and this may affect aircraft safety and efficiency. The wrong information passed to two written media (email and controlled documentation) from the aircraft manufacturer to the Technical Publication Unit would eventually transfer to other core departments in GrA. According to the technical library, officer interviewed, this may occur when the technical documents namely flight manuals and maintenance manuals that accompanied the Illustrated Parts Catalogue (IPC) in a compact disc from the manufacturers, were outdated. This would affect inefficiency of work throughout the departments and it was plain that Engineering Department would usually detect the incorrect information and would inform Technical Publication Unit to seek clarification. The wrong revision of technical documents produced by the manufacturer posed a high risk of misinformation. Hence, aircraft safety and efficiency might be compromised, especially when Licenced Aircraft Engineers and Aircraft Maintenance Technicians performed the maintenance work on aircraft based on outdated procedures.

The findings of this study were similar to those in [8] where the document deficiencies was found to be one of the two major causes (the other being user errors) of incorrect or inefficient maintenance procedures. All three verbal media, meetings, phone call and face to face communication, however, scored low (1 to 16). This is reflected in the interview and observational data, which showed that GrA personnel preferred face to face meetings to solve critical or non-critical issues immediately as they arose. Table 14 below is the summary of two departments' communication procedures that pose a high risk in conveying incorrect, insufficient and unavailable critical information. It suggests that the two procedures that carried critical information using written media had the potential to convey incorrect information. These procedures had relation to aircraft maintenance work and were likely to jeopardise aircraft safety and efficiency if they were not detected and improved promptly.

**Table 14.** Summary of departments with high risk in communicating critical information using written media

| Department | Procedures | Written Media | High Risk |
|---|---|---|---|
| Aircraft Maintenance Department with the Planning Department | Aircraft Status List & Maintenance Forecasting | Software & Documentation | Incorrect information |
| Technical Publication Unit with GrA core departments | Flight Manuals, Aircraft Maintenance Manual, Service Bulletin & Airworthiness Directives | E-mail & Documentation | Incorrect, Insufficient & Unavailable information |

The overall results also agree that the Media Richness Theory [3, 4] has proven that written media such as documentation, electronic mail and software are less rich and pose a higher risk to due to incorrect, insufficient and unavailable critical information that may lead to maintenance errors and aircraft delay. On the other hand, verbal media, for example, face to face communication, phone calls and meetings were suggested as carrying a low risk of misinterpretation as any incorrect or unclear critical information was thoroughly discussed and clarified as they arose. However, the study has also shown that instead of relying solely on the written media to interpret the message, both technical and non-technical personnel did take the initiative to confirm any information that was considered to be equivocal by utilising the rich media (face to face, phone call and meetings).

## 6. Conclusion

The study reveals a scenario of verbal and written communication in conveying critical information in an aircraft maintenance organisation. Looking at the bigger picture, written media in the maintenance organisation can potentially affect aircraft safety and efficiency in the following situations.

Aircraft safety and efficiency can be affected due to incorrect, insufficient and unavailable information and if it was not detected earlier, it can be taken and used as true information. It would be more harmful if the same information was passed through from one person to the other; this could create a greater problem, especially when maintenance, repair and overhaul work on aircraft is carried out. Early discovery of errors could save time and cost. Consequently, maintenance work on aircraft can be carried out accordingly. Another factor in communication failure is the misinterpretation of the content by the user. Even though the information conveyed in the written media carries complete, correct and clear information, misunderstanding of the message leads to the creation of misunderstood information in the reader's mind. This could also jeopardise aircraft safety and efficiency when the wrong interpretation of the initially correct information being passed from one department to the other thus result in maintenance errors.

Written media such as the technical manuals are documented and are referred to by aircraft maintenance personnel, to be used in daily maintenance operations. How it is written and presented plays a vital role in making sure every user understands the content; the outcome of the work produced should be as it was intended to be. However, one person may have a different interpretation and understanding of the message most probably because of his/ her knowledge and experience. If a common understanding of the written media is not achieved through open discussions among Licensed Aircraft Engineers and Aircraft Maintenance Technicians, then mistakes will happen. The verbal media of communication, however, posed a lower risk in conveying critical information in the maintenance organisation. This was because verbal clarification took place whenever misunderstanding of critical information was detected. The confirmation and verification of uncertain or potentially incorrect or insufficient information were carried out through face to face discussion. Therefore, verbal media carried a low risk in affecting aircraft safety and efficiency.

## Acknowledgements

Thank you to Universiti Kuala Lumpur Malaysian Institute of Aviation Technology and University of Aberdeen, Scotland for the strong support.

**References**

[1] Shannon C E 1948 *The Bell System Technical Journal* **27** 379-423
[2] Ma J, Drury C G and Marin C V 2009 *The International Journal of Aviation Psychology* **20** 25-47
[3] Daft R L and Lengel R H 1986 *Management Science* **32** 554-71
[4] Daft R L and Lengel R H 1984 *Research in organizational behavior* **6** 191-233
[5] Sheer V C and Chen L 2004 *Management Communication Quarterly* **18** 76–93
[6] Cushing S 1994 *Fatal Words: Communication Clashes and Aircraft Crashes* (Chicago: University of Chicago Press)
[7] Hobbs A 1999 *Asia-Pacific Air Safety* **21** 2-7
[8] Lattanzio D, Patankar K and Kanki B G 2008 *The International Journal of Aviation Psychology* **18** 17-29
[9] CAA 2003 *CAP 716: Aviation Maintenance Human Factors (EASA/JAR145 Approved Organisations) Guidance Material on the UK CAA Interpretation of Part-145 Human Factors and Error Management Requirements*
[10] ICAO 2010 *Annual Report of the Council*
[11] Chaparro A and Groff S L 2001 *Human Factors Survey of Aviation Technical Manuals* Federal Aviation Administration
[12] William L R, Shappell S and Wiegmann D 2008 *Human Factor Guide for Aviation Maintenance and Inspection* Federal Aviation Administration